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VOLUME 60 APRIL 1974 NUMBER 2

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AGE AND GROWTH OF THE PACIFIC SAURY, *COLOLABIS SAIRA*[1]

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Age, sex ratio, maturity, age composition, and length-weight relationships of Pacific saury, *Cololabis saira*, were studied using samples collected from waters off southern Oregon to central Baja California. Lengths ranged from 45–300 mm FL. Age was determined from otoliths, and length frequency distributions were used to validate the otolith method. Of the 237 sauries whose ages were determined, 57% were Age Group II fish ranging from 208–276 mm FL. Sexual maturity was most developed during winter and spring months. The calculated length-weight relationship of unsexed fish is: weight $= 0.00008309L^{3.19591}$. Female to male ratio was 1.1 to 1.

INTRODUCTION

The Pacific saury, *Cololabis saira* (Brevoort), is found throughout the north Pacific Ocean and is of commercial importance to the U.S.S.R. and Japan. Because of its commercial potential and foreign interest, this species has received recent attention along our coast. The western Pacific stock has been studied, but little is known about the eastern Pacific stock. My study was initiated to obtain age and growth information about the eastern Pacific stock.

Age determination of saury is difficult, and conflicting views on the subject exist between Soviet and Japanese researchers. Both groups have had success in using scales although the Japanese feel otoliths may be used. I obtained better results with otoliths and used them.

METHODS AND MATERIALS

A total of 1,132 sauries was collected between September 1970 and September 1972 during cruises of the California Department of Fish and Game vessel *Alaska* and from one commercial catch in October 1971. The sampling area extended from southern Oregon to central Baja California. *Alaska* samples were collected by dip net at night-light stations while the commercial sample was caught by purse seine. A sample of 10 fish from Japan also was utilized for age determination.

Sauries were measured to the nearest millimeter fork length (FL) and weighed to the nearest 0.1 g. Otoliths were taken from 293 fish and were measured by an ocular micrometer to the nearest 0.001 mm.

The fork length-otolith length relationship was derived from 193 fish. A total of 206 pairs of otoliths was used for calculating the otolith-age relationship.

The largest of the three pairs of otoliths, the sagitta, was used. They were placed in a small gelatine capsule and dried. When the otoliths were read, they were immersed in $\frac{1}{4}$ inch water, and a 20 power binocular microscope was used in determining the number of annuli present.

The determination of age is based on the hypothesis that a white opaque crystalline zone is deposited on the otolith during spring and

[1] This study was conducted in cooperation with the Department of Commerce National Oceanic and Atmospheric Administration, National Marine Fisheries Service, under Public Law 88-309, Project 6-3-R. Accepted for publication December 1973.

summer when growing conditions are optimal. During winter months, when growth is retarded, a translucent (hyaline) winter zone is laid down (Jensen 1965). The completed annual ring is defined as an interface between the inner hyaline zone (annulus) and outer white opaque zone (Fitch 1951; Chuganova 1959). Age determination from length frequency distribution (Peterson method) was used to determine the reliability of otolith age determination methods.

RESULTS

Determination of Birthday

In order to establish a birthday as a basis for age determination, the spawning period and time of ring formation must be known. Materials collected during December 1971 to September 1972 were used for determining ring formation. A total of 127 pairs of otoliths were examined and results indicate the highest incidence of hyaline deposition occurred during winter and spring months (Figure 1).

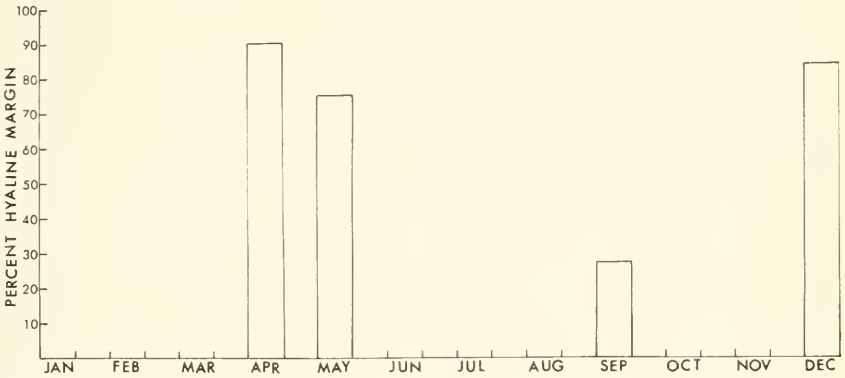

FIGURE 1. Seasonal change in the margin of the otolith of the Pacific saury.

The peak spawning period must also be known to denote age groups. Pacific sauries are known to spawn all year, but Smith, Ahlstrom, and Casey (1971) found peak spawning during spring months, the highest frequency occurring in May. Based on these data, I chose May 31 as the arbitrary "birthday".

Age Composition, Otolith Method

Samples taken during the summer of 1972 between the Oregon border and Monterey Bay were utilized for age determination. While 293 pairs of otoliths were available, 237 pairs were readable with a certain degree of confidence and were used for this study.

The age composition consisted of five age groups, 0 through IV. The 0 Age Group (young of the year) ranged from 122 to 206 mm FL with a mean of 171 mm and a standard deviation of 21.8 mm (Figure 2). Such a range is expected when dealing with fish that have a long spawning season (Smith, Ahlstrom, and Casey 1971). Age Group I (otoliths with one completed hyaline and one opaque zone) had a mean length of 220.1 mm (range 180–265 mm FL) while Age Group II (otoliths with two completed hyaline and two opaque zones) averaged 245.5 mm (range 208–276 mm FL), and the standard deviations did

overlap. The mean lengths of the two age groups were significantly different (5% level) when subjected to a t-test. The t-value was 12.06 with 174 degrees of freedom. Age Group III and Age Group IV had mean lengths of 270 mm (range 238–300 mm) and 268 mm (range 258–277 mm) FL respectively. Again, an overlap of the standard deviations occurred but when the mean lengths were subjected to a t-test, they were not significantly different. Since the numbers of fish in the last age group were few, the mean value may not be representative. Although the length ranges did overlap between various age groups, the standard error of means of the first four age groups did not overlap (Figure 2). Mean lengths at age for male and female fish were compared, and no significant differences were observed.

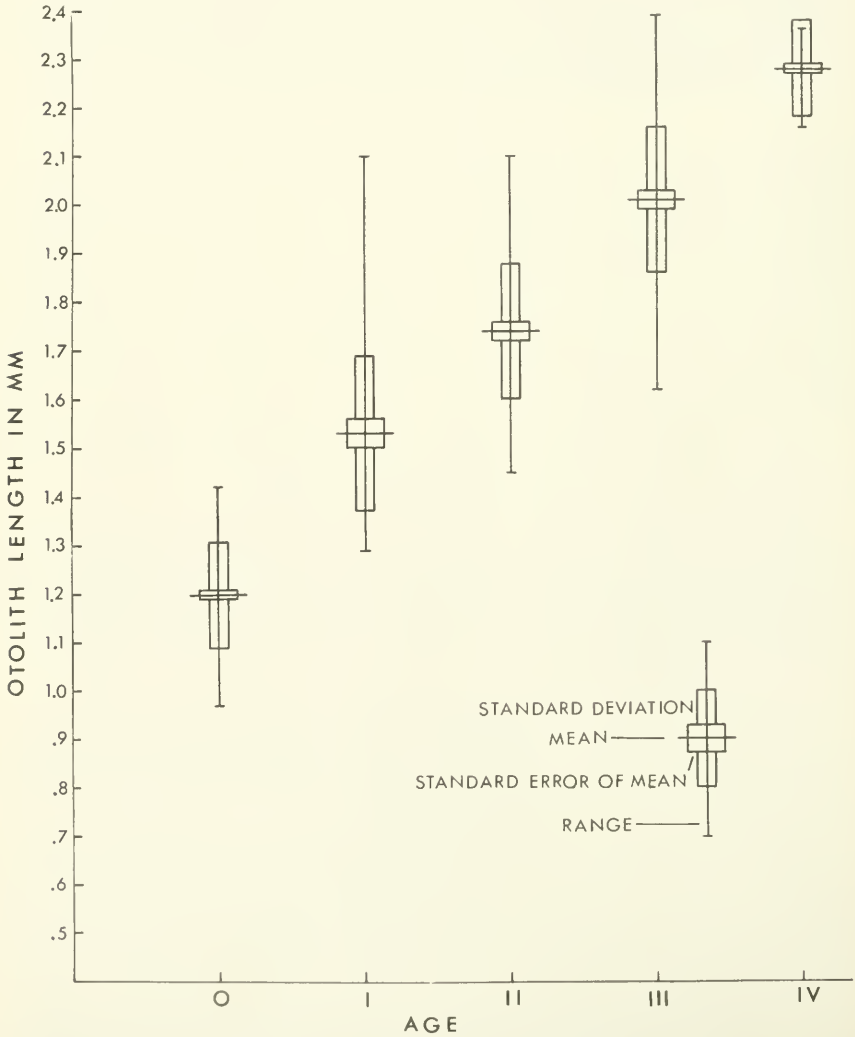

FIGURE 2. Mean lengths of Pacific saury age groups derived from otolith readings.

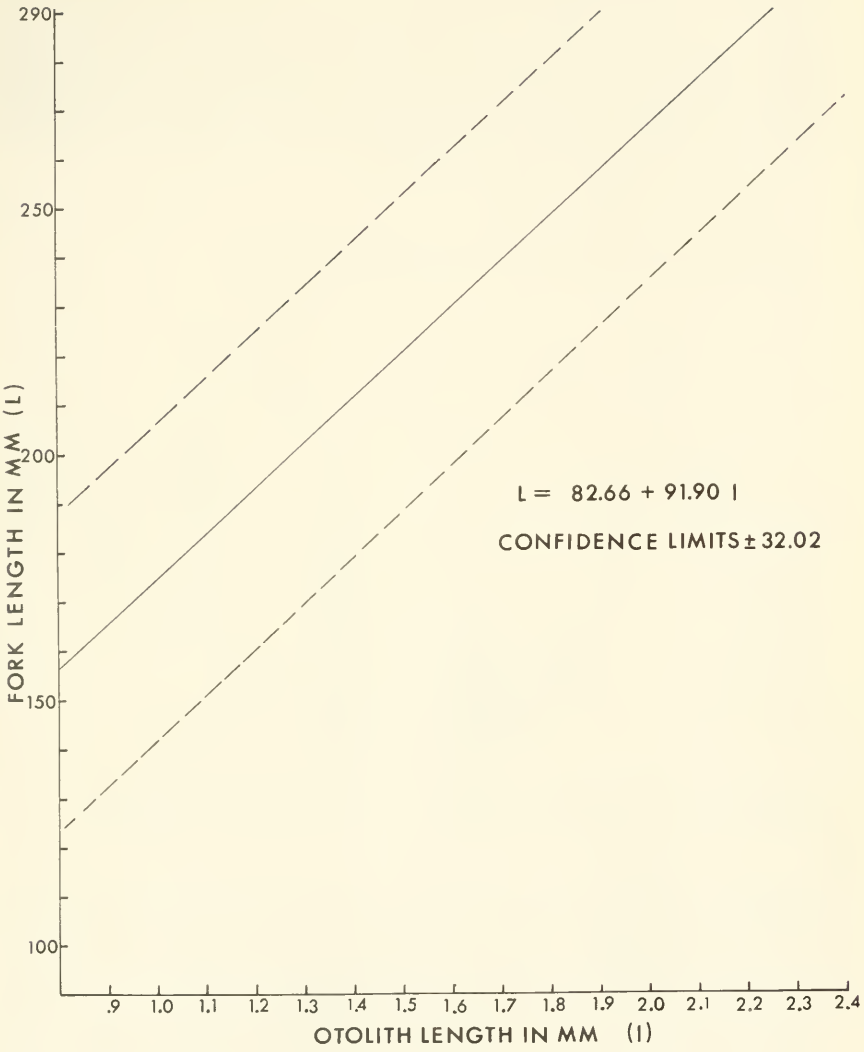

FIGURE 3. Relationship between otolith length and fork length of Pacific saury.

As a comparison, the ages of 10 imported western Pacific fish were determined. The dominant Age Group II had a mean length of 276 mm FL which was larger than the mean length of the eastern Pacific saury of the same age group.

Eastern Pacific fish of Age Group II dominated the age composition with 57% of 237 fish aged, while Age Groups I and III fish each had 16.9%. Age Group 0 consisted of 8%, and Age Group IV with 1.7% of the total.

Observations on the fork length-otolith length relationship were fitted to a linear regression. The equation used was:

$$L = 82.660 + 91.900l$$

where: L = fork length (mm)
l = otolith length (mm)

The fit was plotted with a correlation coefficient of 0.812 and 95% confidence. Limits were calculated (Figure 3). The validity of the relationship was reinforced by an otolith length-age relationship (Figure 4). The results indicate that otolith length (l) shows a linear dependency on age (X) as described by the equation:

$$l = 1.255 + 0.246X$$

where: X = age of fish

The correlation coefficient was calculated as 0.800.

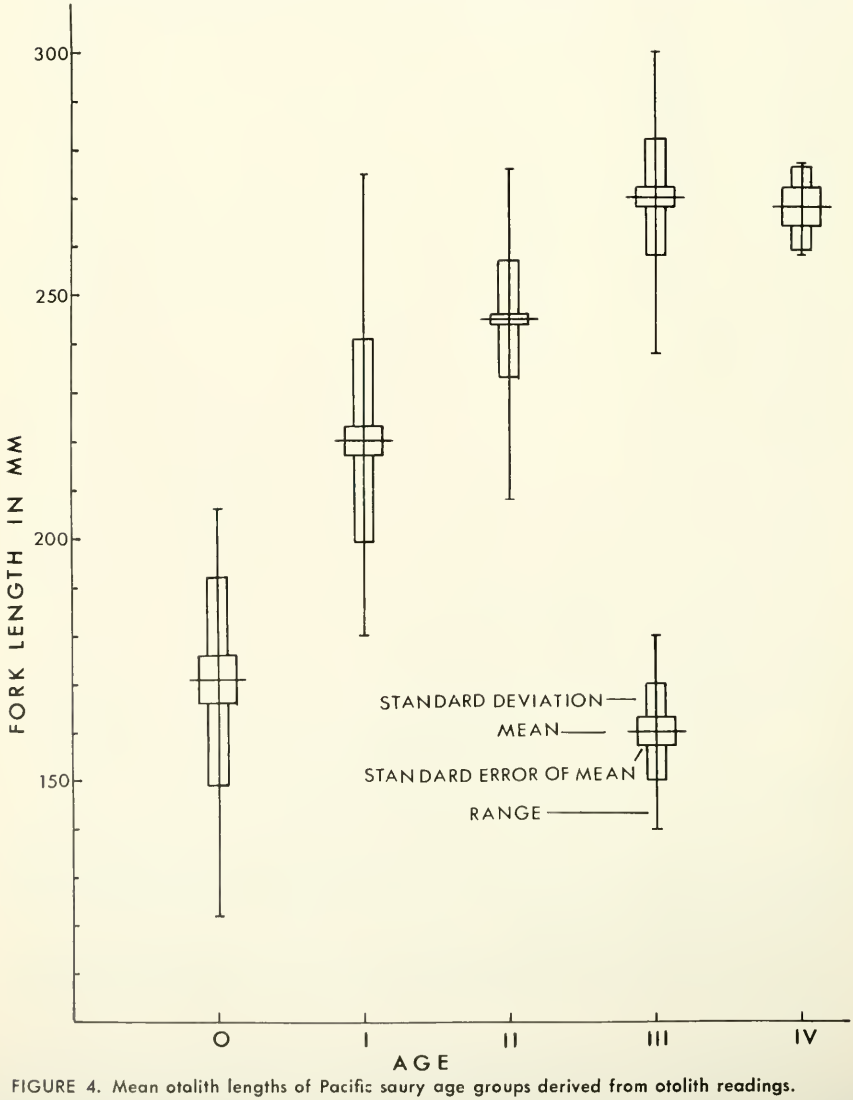

FIGURE 4. Mean otalith lengths of Pacific saury age groups derived from otolith readings.

Length Frequency Method

A total of 558 measurements taken during September 1972 was used for this method. Age Group 0 was readily discernable. In this age group, the most prominant mode was near 65 mm (range 45 to 145 mm) although several other peaks were noted, indicating a long spawning season (Figure 5). Although sauries spawn throughout the year, CalCOFI egg and larval surveys indicate winter and spring months as dominant spawning months (Smith, Ahlstrom, and Casey 1971).

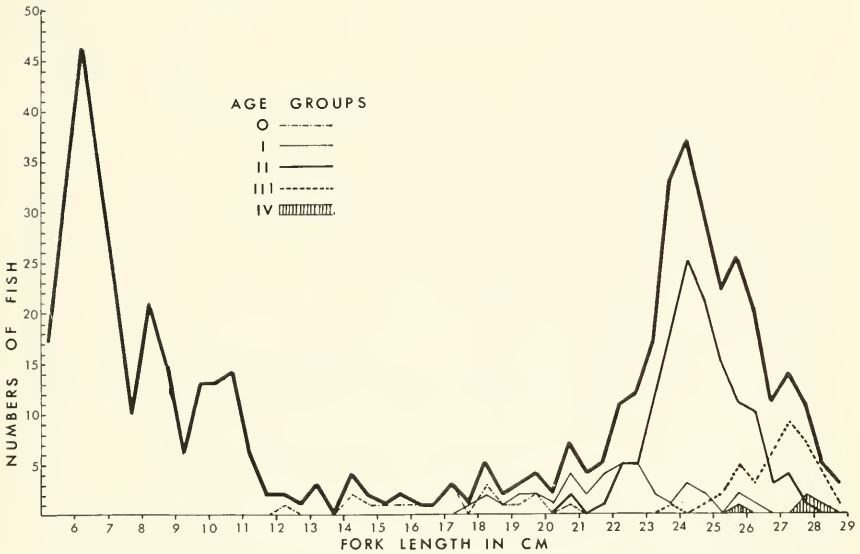

FIGURE 5. Length-frequency distribution and distribution of the first five age groups of Pacific sauries collected aboard the *R/V Alaska* off northern California, September 1972.

The next mode occurred near 210 mm (range 200 to 220 mm), and within this mode Age Groups I and II were found with a predominance of Age Group I. The second largest mode is located near 245 mm (range 230 to 265 mm). A majority of otoliths from this size group had two hyaline zones with some otoliths with one or three completed hyaline zones. Beyond this peak, two peaks at 260 and 275 mm occurred. These peaks contained four age groups; I through IV, with a predominance of 2 year old fish in the 260 mm size group and 3 year old fish in the last modal peak. Two factors that could account for the overlap are wide variation in size and mortality within older age groups. Another explanation for the overlap is the fact that sauries tend to school according to size, even though fish of different ages are found in these schools (Hatanaka 1956).

As a result of comparing length frequency modes, several age groups were discernable. The 0 Age Group was quite distinct, whereas Age Groups I and IV were less well defined, possibly due to the small numbers of specimens in these length ranges. Age Groups II and III were discernable by modal peaks and correlated with otolith readings.

Length-Weight Relationship

Data from 205 fish obtained from northern California to southern California were used to construct a length-weight curve. The sizes of these fish ranged from 71 to 300 mm FL and weights from 1 to 127 g.

The growth curve displayed an exponential increase in weight with length, fitting the formula $W = aL^b$. The calculated length-weight relationship of unsexed fish is:

$$\text{weight} = 0.00008309L^{3.19591}$$

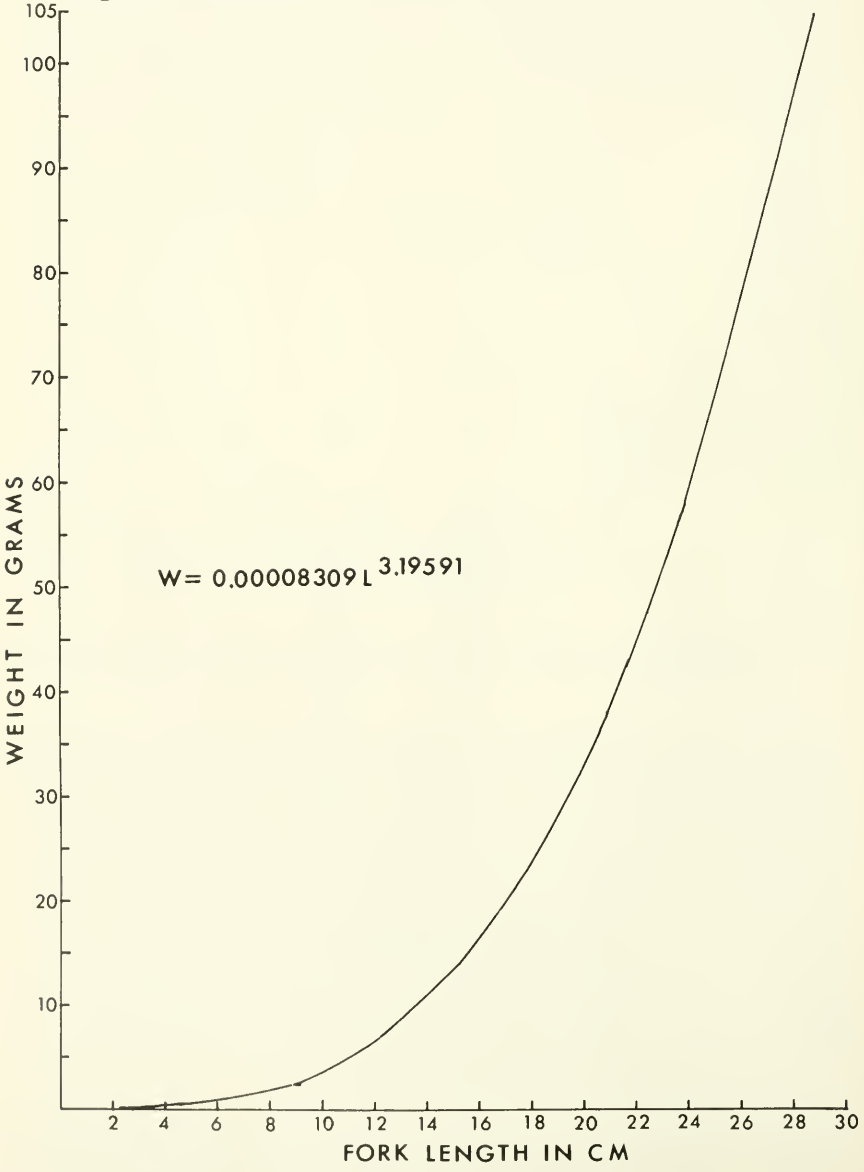

FIGURE 6. Length-weight relationship of Pacific saury.

with a correlation coefficient of 0.997 (Figure 6). Separate length-weight calculations were made from males and females from the different sampling areas. The southern California sample consisted of 86 males and 70 females. The values are:

$$\text{female weight} = 0.0000708 3L^{3.10644}$$
$$\text{male weight} = 0.00007516L^{3.1206}$$

with a correlation coefficient of 0.977 and 0.966 respectively. The length-weight calculations for the northern California sample were very similar to those from southern California. These calculations were based on 107 males and 141 females. The results are:

$$\text{female weight} = 0.00008704L^{3.20814}$$
$$\text{male weight} = 0.00006973L^{3.14000}$$

with a correlation coefficient of 0.980 and 0.984 respectively.

Sex Ratio

Data pertaining to sex and maturity from 423 fish were recorded. Sex determination was possible only on fish larger than 125 mm FL although maturity does not occur until later. Fish smaller than 125 mm could not be sexed accurately. The female to male ratio was 1.1:1; however, a ratio of 1:1 appeared more constantly throughout the season in all regions where samples were taken (Table 1). Maturity of females was most developed during winter and spring. Since spawning fish were less available to the sampling gear, adequate numbers could not be collected during the winter and spring season.

TABLE 1. **Male-Female Ratio of Pacific Saury**

Month	Area	Percent ripe females	Females	Males	F:M ratio
1971					
June	Baja Calif.	0.0	11	12	0.92:1
August	Baja and So. Calif.	0.0	5	4	1.25:1
October	So. Calif.	0.75	39	41	0.95:1
December	So. Calif.	60.0	5	6	0.83:1
1972					
April	So. Calif.	31.0	23	29	0.79:1
*September	No. and Cent. Calif.	0.0	141	107	1.32:1
Total			224	199	
Percent ratio			52.9	47.1	1.1:1

* This sample increased the Female:Male ratio to 1.1:1. Prior to this, the ratio was 0.9:1.

DISCUSSION

Previous investigators have indicated difficulty in accurately determining the age of western Pacific sauries. The most recent and widely accepted Japanese theory is that there are two distinct populations with different spawning periods, one in spring and the other in fall (Hotta 1960). Length and age data indicate separate growth patterns of the two populations. These growth patterns are as follows: 210 to

240 mm are 1 year old, 260 to 280 mm 1.5 years, 290 to 300 mm are 2 years, and 310 to 330 mm are 2.5 years (Hotta 1960). The 1 and 2 year fish are believed to be fall spawned fish while the 1.5 and 2.5 year fish are considered as spring spawned.

Soviet researchers do not believe the presence of two populations of the asiatic stock, although they do find spawning peaks during spring and fall months. Their studies indicate 210 mm fish to be 1.5 years, 250 to 290 mm fish as 2.5 years, and 300 mm fish to be 3.5 years old (NOAA 1970; Inouye and Hughes 1971). The Russians used scales for determining age while the Japanese used both scales and otoliths.

One possible reason for such a discrepancy in age determination is the prolonged spawning periods. While spring and fall are the peak seasons, the fish do spawn all year. As a result varying growth rates occur and depending on the birthday, indications of the first winter ring are present or absent.

I used otoliths as the main source for determining age. Scales were difficult to read and considerable time was involved in mounting them. The accuracy and validity of otolith results have been compared with length frequencies, and several age groups consisting of 0, II, and III were distinguishable by modal peaks in the distribution. The dominant age groups in my study were 0 and II.

The imported sample fish were predominantly Age Group II, and these fish were slightly larger than the California caught fish of the same age group. Catch statistics from the asiatic fisheries indicate a larger average length in the commercial catch.

The Japanese found eastern Pacific saury scale radii and body length relationship to be different from those of the western Pacific stock. These data were based on samples obtained from exploratory cruises off the west coast of North America and their findings suggest varying growth rates between the two stocks (Odate, Tohoku Regional Research Laboratory, pers. comm. 1972).

Differences in the length-weight relationships of western and eastern stock sauries were noted. I found that the eastern Pacific sauries had a length-weight value of:

$$\text{weight} = 0.00008309L^{3.19591}$$

whereas Hotta (1958) found western Pacific sauries, calculated from sauries 210 to 310 mm (commercial size) in length, as:

$$\text{weight} = 0.00009934L^{3.46800}$$

Selection of larger fish from the western stock could account for the difference between the two values.

Since there is yet to be a fishery along our coast, adequate sampling of the stock is impossible. The stock is relatively unexploited; however, this resource has potential and the data that have been assembled may prove valuable in the future.

ACKNOWLEDGMENTS

I wish to thank the personnel of the vessel *Alaska* and the Pelagic Fish Sea Survey Project. Thanks are given to Rick Klingbeil, Ray Ally, and Vickie Wine for assisting me in the data analysis. Herbert Frey reviewed the manuscript and gave helpful editorial assistance. Special thanks goes to Gayle Jones and Micalea Wolfe for their patience and endless hours at their typewriters.

REFERENCES

Anonymous. 1970. Japan-USSR discuss decline of Pacific saury stocks. U.S. Fish and Wildlife Ser. Comm. Fish. Review 32(1) : 70.

Chuganova, N.I. 1959. Age and growth studies in fish. Translated from the Russian by D. Yasski, 1963. Washington, D.C. Natl. Sci. Found. 132 p. (Israel Program for Scientific Translations, Jerusalem.)

Ellis, Ian, and Steven E. Hughes. 1971. Pacific saury, a progress report. National Fisherman Yearbook : 67–92.

Fitch, John E. 1951. Age composition of the southern California catch of Pacific mackerel 1939–40 through 1950–51. Calif. Dept. Fish and Game, Fish. Bull. (83) : 1–73.

Hatanaka, Masayoshi. 1956. Biological studies on the population of the saury, *Cololabis saira* (Brevoort). Part 2, Habits and migrations. Tohoku J. Agr. Res. 6 :313–340.

Hotta, Hideyuki. 1958. On the growth of the young saury, *Cololabis saira*, in the rearing experiment. Bull. Tohoku Reg. Fish. Res. Lab. 11 : 47–64. (In Japanese with English summary.)

———. 1960. On the analysis of the population of the saury (*Cololabis saira*) based on the scale and the otolith characters, and their growth. Bull. Tohoku Reg. Fish. Res. Lab. 16 : 41–64. (In Japanese with English summary.)

Inouye, Michael Shigeru, and Steven E. Hughes. 1971. Pacific saury (*Cololabis saira*) a review of stocks, harvesting techniques, processing methods and markets. Engineering Exp. Sta. Oregon State Univ., Bull. 43 : 1–101.

Jensen, Albert C. 1965. A standard terminology and notation for otolith readers. Inter. Comm. Northwest Atlantic Fish., Res. Bull. (2) : 5–7.

Smith, Paul E., Elbert H. Ahlstrom, and Harold D. Casey. 1971. The saury as a latent resource of the California Current. Calif. Coop. Oceanic Fish. Invest. Rep. 14 :88–130.

Calif. Fish and Game, 60(2) : 74–78. 1974.

A DESCRIPTION OF THE LABORATORY-REARED FIRST AND SECOND ZOEAE OF *PORTUNUS XANTUSII* (STIMPSON) (BRACHYURA, DECAPODA)

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***Portunus xantusii* (Stimpson) was reared in the laboratory from the egg through the second zoeal stage. The larvae were reared under simulated day and night conditions at a temperature range of 23 to 26.5 C and a salinity range of 33.5 to 33.6‰. The first two zoeal stages are fully described and figured.**

INTRODUCTION

Portunus xantusii (Stimpson), a swimming crab, is found from Santa Monica Bay, California (Rathbun 1930) to Chile (Johnson and Snook 1927). This study describes the first and second zoeal stages as an aid to the identification of this crab in plankton samples.

MATERIALS AND METHODS

An ovigerous *P. xantusii* was captured in San Pedro Bay, near Seal Beach, California, on August 27, 1971, and transported to the laboratory at California State University, Long Beach, where it was placed in an aerated 8 liter container. The eggs hatched approximately 3 hr after the crab was captured. Thirty-five first zoeae were placed in each of ten 266 mm plastic cups. The study was conducted at ambient laboratory temperatures ranging from 23 to 26.5 C and day and night conditions were simulated. Sea water was obtained from Seal Beach and transported to the laboratory in 19 liter plastic carboys. The water was filtered through two number one Whatman qualitative filter papers. The salinity of the water varied from 33.5 to 33.6‰. The larvae were transferred daily, by means of a pipette, into clean cups containing new sea water. The water in these cups was not aerated. Nourishment for the zoeae was provided in the form of freshly-hatched *Artemia salina* nauplii.

In order to avoid mortality due to bacterial infection, a commercial preparation of penicillin and streptomycin was used. The volume of sea water used each day was treated with 0.2 cc of the preparation per liter of sea water.

All zoeae and exuviae were preserved in a 5% solution of formalin. From 5 to 10 specimens were used to study external anatomical variation. Appendages were dissected with fine insect pins and mounted in glycerin. All figures were drawn with the aid of a camera lucida.

RESULTS

All series of armature are listed in the description from proximal to distal.

First Zoea

The carapace of the first zoea (Figure 1-A) has a rostral and dorsal spine, and a pair of lateral spines. The mean of the perpendicular

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distance between the tip of the rostral spine and the tip of the dorsal spine is 1.09 mm. There is a small hair or setule present above each lateral spine. The eyes are not stalked. The abdomen (Figure 1-B) consists of five segments or somites and a bifurcated telson. The postero-

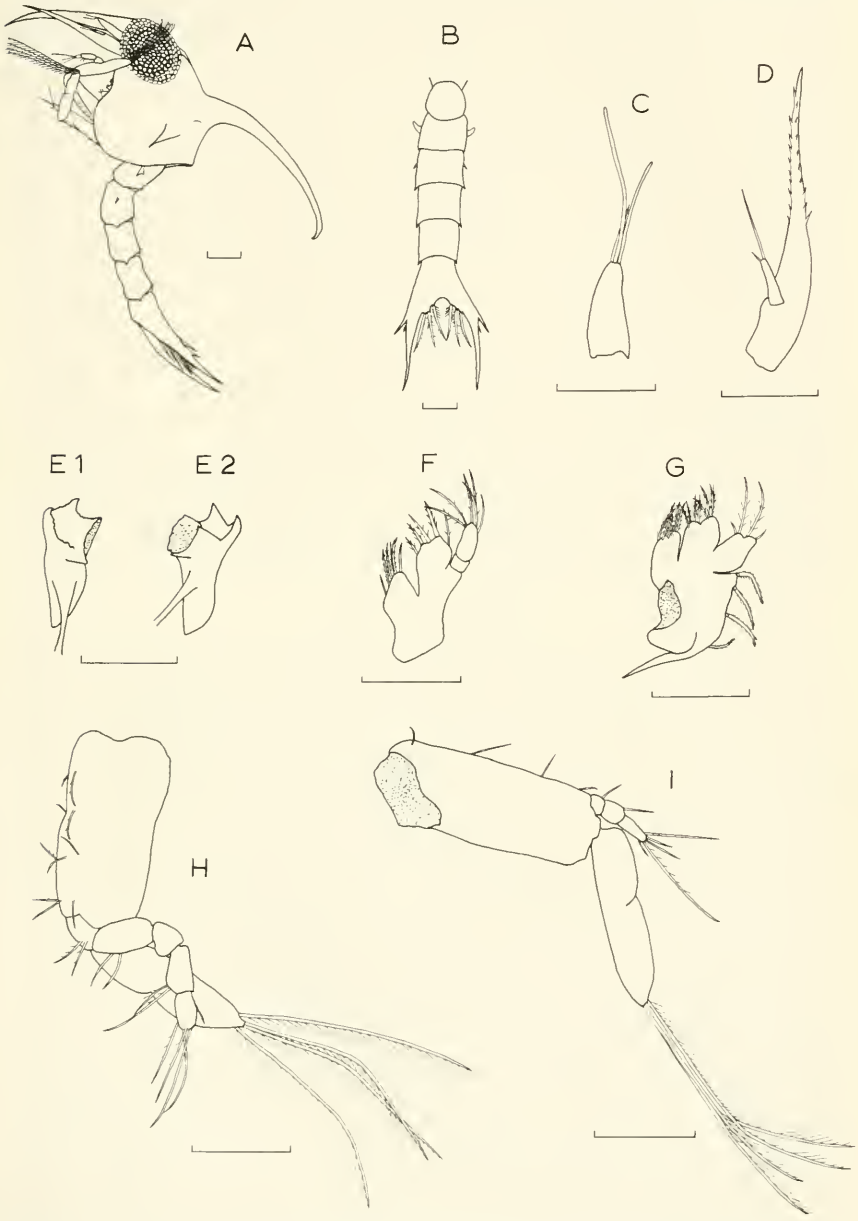

FIGURE 1. First zoea of *Portunus xantusii* (Stimpson). A, lateral view; B, ventral view of abdomen; C, antennule; D, antenna; E-1 and E-2, right and left mandibles respectively; F, maxillule; G, maxilla; H, first maxilliped; I, second maxilliped. Scale = 0.1 mm.

lateral edges of somites three through five extend caudally as spines, overlapping the adjacent somite. The second somite bears a pair of lateral hooks and the third somite, a pair of lateral spines. A pair of setules is present on the posterodorsal border of somites two through five. The first somite has no ornamentation. Each furca of the telson has three plumose setae on the inner margin, two smooth and unequal spines on the outer margin, and another smooth spine (not shown in Figure) on the dorsal side posterior to the latter two. The antennule (Figure 1-C) bears two long, unequal aesthetes and one seta. The antenna (Figure 1-D) has a protopodite which terminates as a long denticulate spine, and a shorter exopodite bearing two unequal terminal setae. The right and left mandibles (Figure 1, E-1 and E-2 respectively) differ slightly in structure. The two-segmented endopodite of the maxillule (Figure 1-F) has no armature on the first segment and six setae on the terminal segment, most of which are plumose. The basipodite and coxopodite bear five and six setae respectively, most of which are plumose. Four plumose setae fringe the border of the scaphognathite of the maxilla (Figure 1-G). The bilobed endopodite has two setae on each lobe. The bilobed basipodite and coxopodite bear 4-4 and 3-3 plumose setae respectively. The protopodite of the first maxilliped (Figure 1-H) has a setal arrangement of 2-2-3-3, most of which are plumose. The five-segmented endopodite has a formula of 2, 2, 0, 2, 5. The protopodite of the second maxilliped (Figure 1-I) has an arrangement of 1-1-1-1, and the three-segmented endopodite has a formula of 1, 1, 5. The exopodite of the first and second maxillipeds is incompletely segmented and bears four long plumose setae.

Second Zoea

The mean of the distance from rostral spine to dorsal spine of the second zoea (Figure 2-A) is 1.28 mm. This is an increase of 17% over the previous stage. Setules on the carapace have increased to six and there are two setules on the dorsal spine. There is a plumose seta on each side of the ventrolateral margin of the carapace. The eyes are now stalked. The posterolateral spines of somites three through five of the abdomen (Figure 2-B) have increased considerably in size. The telson has added a naked seta on each side of the fureal angle and there has been a reduction in size of the smaller spine on the outer margin of each furca. The antennule (Figure 2-C) now bears five aesthetes and one very small seta (not shown in the Figure). Other than the increase in size, the antenna (Figure 2-D) and mandibles (Figure 2, E-1, and E-2) are unchanged. There is no change in the armature of the endopodite of the maxillule (Figure 2-F), but the basipodite now has seven setae. The setation of the coxopodite is generally six and rarely seven. A seta has been added to the lateral border of the protopodite, below the endopodite. There are seven setae on the border of the scaphognathite of the maxilla (Figure 2-G), and the formula of the bilobed endopodite is now 2–4. There is no change in the armature of the basipodite and coxopodite. The armature of the protopodite and endopodite of the first maxilliped (Figure 2-H) is unchanged. The now completely segmented exopodite has generally six plumose setae, rarely five and seven. The protopodite and endopodite of the second maxilliped (Figure 2-I) have no armature change. The plumose setae of the still incompletely segmented exopodite have increased to six.

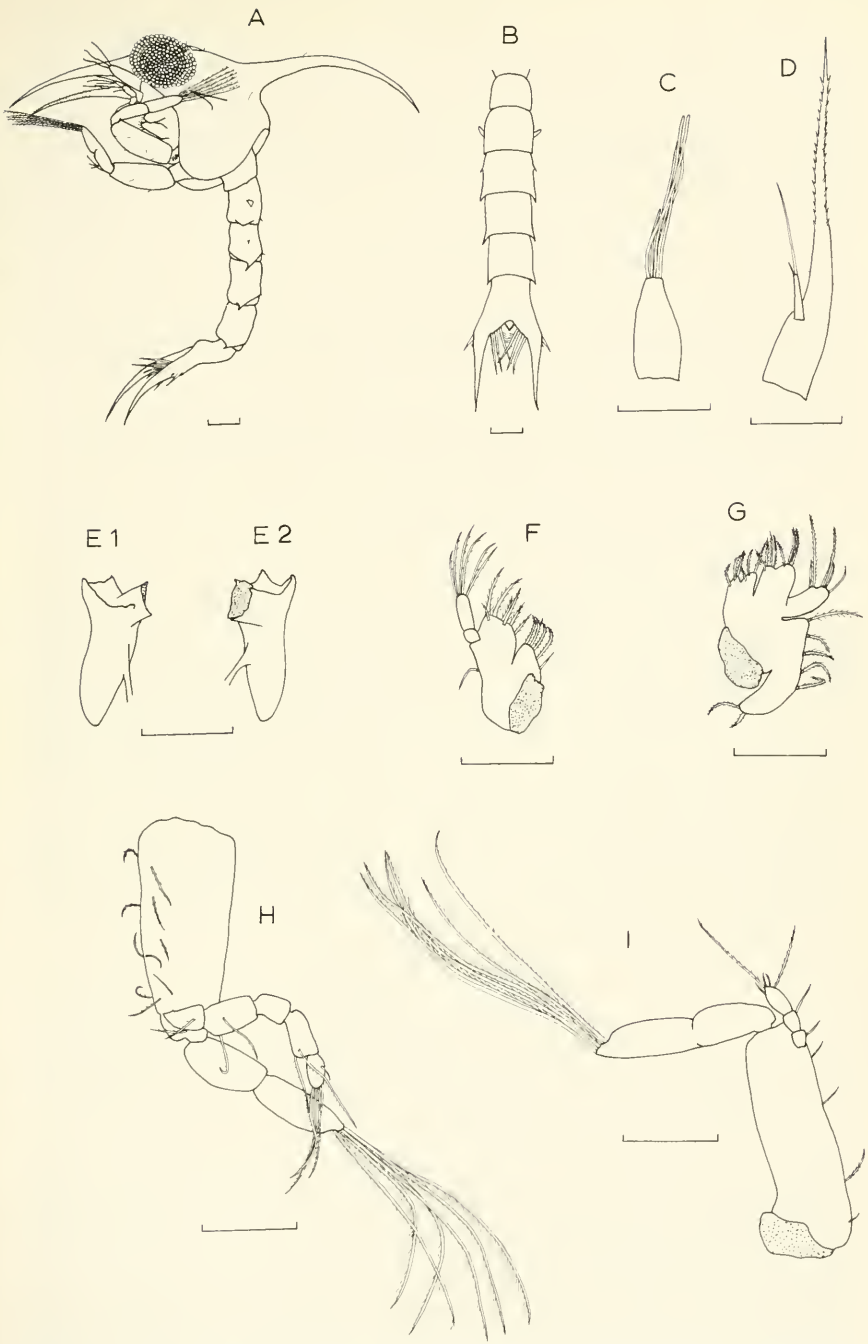

FIGURE 2. Second zoea of *Portunus xantusii* (Stimpson). A, lateral view; B, ventral view of abdomen; C, antennule; D, antenna; E-1 and E-2, right and left mandibles respectively; F, maxillule; G, maxilla; H, first maxilliped; I, second maxilliped. Scale = 0.1 mm.

DISCUSSION

Of the initial 350 zoeae, three molted into the second zoea 9 days after hatching and another two molted 11 days after hatching. All second zoeae died within 4 days after reaching this stage, and all zoeae were dead 15 days after hatching. This very high mortality was probably due to the high temperatures at which the larvae were kept. The ambient temperature of the collecting area was to be approximated during the study, but the cooling unit which was to be used became inoperative.

Since hatching of the eggs occurred only 3 hr after the capture of the ovigerous crab, embryonic development took place almost entirely under natural conditions. Therefore, there should be very few differences, if any, between the first zoea described and that found in nature. However, since the second zoea described developed at abnormally high temperatures, differences between it and that found in nature might exist.

Lebour (1928) stated that there are four to five zoeal stages in the family Portunidae and five zoeal stages in the subfamily Portuninae. Accordingly, *P. xantusii* should have five zoeal stages. However, Costlow, and Bookhout (1959) reported as many as eight zoeal stages in *Callinectes sapidus* Rathbun reared under laboratory conditions. They also indicated that this number might not be representative of that found under natural conditions.

Lebour (1928) stated that it is practically impossible to distinguish among the zoeae of *Portunus, Bathynectes,* and *Polybius. Callinectes* might also be added to these genera. Length ratios such as the lateral spine to rostrum ratio and the antennal exopod to antennal peduncle ratio have been suggested by Roberts (1969) as a means of separating the genera of Portunidae. However, as Roberts further indicated, much more knowledge of larval histories is needed to establish the validity of these ratios in separating the genera.

Since portunid larval stages are very similar, it is necessary to use a combination of diagnostic characters to identify species. Those characters most useful are: the perpendicular distance between the tip of the rostrum and the tip of the dorsum, and the armature of the antennule, maxillule, and mixilla.

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I wish to thank the following faculty members of California State University, Long Beach, California: R. Ward Renshaw, for his support of this study; Murray D. Dailey, for providing the needed antibiotics; H. Everett Hrubant, for the use of his X-ray viewer as a drawing aid; and Ju-Shey Ho, for reviewing the manuscript.

REFERENCES

Costlow, John D., Jr., and C. G. Bookhout. 1959. The larval development of *Callinectes sapidus* Rathbun reared in the laboratory. Biol. Bull. 116(3): 373–396.

Johnson, Myrtle E., and Harry J. Snook. 1927. Seashore animals of the Pacific coast. Macmillan Co., New York. 659 p.

Lebour, Marie V. 1928. The larval stages of the Plymouth Brachyura. Zool. Soc. London, Proc., Part 2: 473–560.

Rathbun, Mary J. 1930. The cancroid crabs of America of the families Euryalidae, Portunidae, Atelecyclidae, Cancridae and Xanthidae. U. S. Nat. Mus. Bull. 152. 609 p.

Roberts, Morris H., Jr. 1969. Larval development of *Bathynectes superba* (Costa) reared in the laboratory. Biol. Bull. 137(2): 338–351.

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THE CALIFORNIA SEA LION ON ISLANDS OFF THE COAST OF SAN LUIS OBISPO COUNTY, CALIFORNIA

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The numbers of California sea lions on six small islands near the coast of San Luis Obispo County, California, were counted each month from May 1971 to May 1972. The greatest numbers were seen in July (1,390) and the fewest in December (230). Age and sex composition are discussed in terms of trends in the frequency of sea lions throughout the year. What these fluctuations in observed numbers mean in relation to the annual cycle of sea lions is still unknown.

INTRODUCTION

Little is known about the yearly changes in the numbers of California sea lions, *Zalophus californianus*, on small rocky islands off the coast of San Luis Obispo County, California. Bonnot (1928) reported approximately 125 animals on four of these islands, but gave few details. Rowley (1929) reported seeing 150 Steller sea lions, *Eumetopias jubatus*, and approximately 100 "breeding" California sea lions. Approximately 1,300 California sea lions and nine Steller sea lions were seen at Lion Rock, San Luis Obispo County, on September 1, 1968 (Peterson 1968).

Carlisle and Aplin (1971) reported an aerial count of 1,104 sea lions from Point Lobos, Monterey County, to Point Conception, Santa Barbara County, during June 1970. From their data, an average midsummer total of 720 animals (range 337–1,524) has been recorded, each year since 1927, along this portion of the central coast of California.

Studies of the numbers of California sea lions throughout the year at specific locations were conducted to update census data and to establish the possible role these islands play as migratory hauling grounds.

MATERIALS AND METHODS

Six small islands, all within 1 km of the coast of San Luis Obispo County, are used as hauling grounds by sea lions (Figure 1). The islands are from north to south: Piedras Blancas Rocks (lat 35° 30′ N, long 121° 20′ W), Lion, Pup and Diablo Rocks (lat 35° 9′ N, long 120° 53′ W), and Pecho Rock (lat 35° 7′ N, long 120° 50′ W). A Cessna 150 airplane was used to fly over the islands to census the animals. Flights were made on September 15, 1970; May 14, November 21, 1971; and April 27, 1972. Each day was sunny and clear, the times spent observing were between 12 noon and 2:00 p.m. Thirty-five millimeter high-speed Ektachrome photographs were taken of the islands at elevations between 200 and 400 feet at flying speeds of 50–70 mph.

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Direct surface counts of animals at Pecho, Diablo, Pup and Lion Rocks were also made by using a small out-board motor boat. This method ensured a more reliable means of identification of the relative age, sex and species of individuals. Counts were made under cloudy skies from 8:00 a.m. to 10:00 a.m. on the following dates: June 11, July 16, August 13, September 16, October 15, and December 16, 1971; January 18, March 2, and May 25, 1972.

RESULTS AND DISCUSSION

Census data indicate that these offshore islands are important hauling grounds for the California sea lion and that a larger population exists than was formerly reported (Table 1). It is estimated that an average of 1,300 or more sea lions may frequent these islands at any one time during the breeding season (May–July) and thus it is suggested that a more detailed account be given to future population censuses along this portion of the central coast.

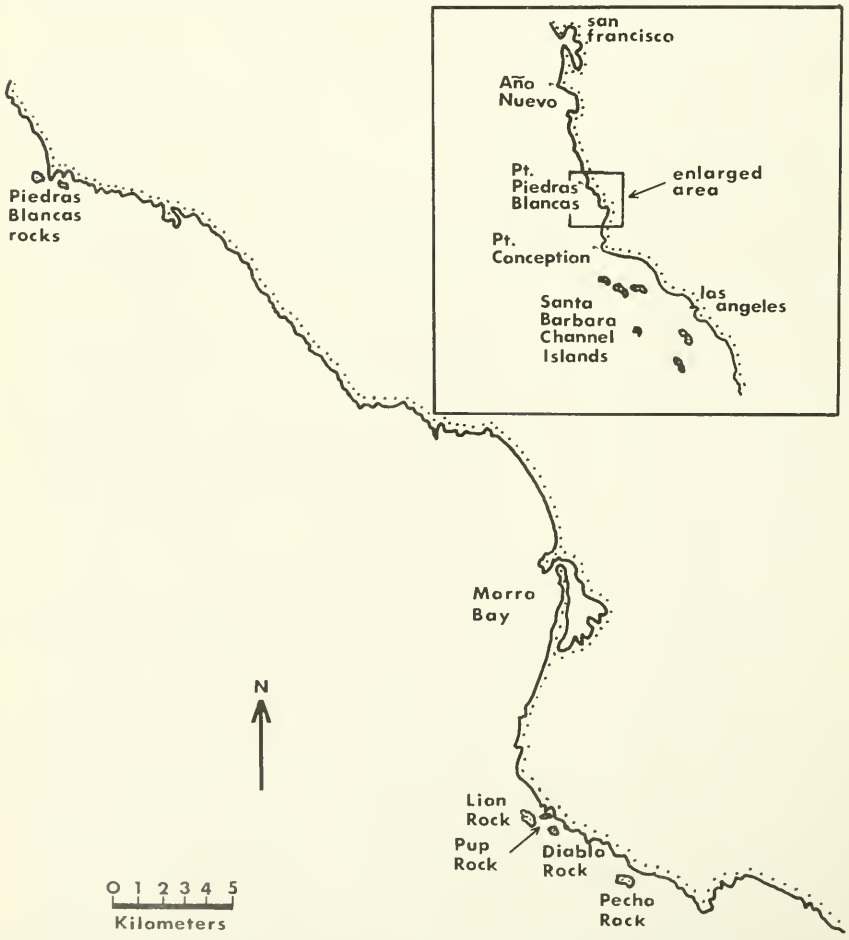

FIGURE 1. Location map of the coastline of San Luis Obispo County, California, where census counts of California sea lions were made from May 1971 to May 1972.

TABLE 1. **Census Counts of California Sea Lions, *Zalophus californianus*, on Six Islands Off the Coast of San Luis Obispo County, California**

Islands	Pecho	Diablo	Pup	Lion	Piedras South	Blancas North	Totals
1970							
Sept 15 A	950	25	25	750	74	200	2024
1971							
May 14 A	414	52	0	553	106	349	1474
June 11 S	600	10	57	611	--	--	1278
July 16 S	606	12	25	747	--	--	1390
Aug 13 S	551	17	34	703	*20	*50	1375
Sept 16 S	409	7	11	655	--	--	1082
Oct 15 S	307	5	3	448	--	--	763
Nov 21 A	96	4	4	213	106	78	499
Dec 16 S	76	2	1	151	--	--	230
1972							
Jan 18 S	40	0	0	203	--	--	243
Mar 2 S	19	5	0	229	--	--	253
Apr 27 A	85	9	0	278	95	10	477
May 25 S	304	19	5	468	--	--	796

A aerial counts.
S surface counts.
* an estimate; counts made from mainland.

Counts on Piedras Blancas Islands are incomplete for the year. The total number of animals reported for all islands, especially in June and July, should thus be greater than reported. One additional island not included in the census, yet close to the other islands, was observed on two occasions (June and July 1971) to have in excess of 100 animals. The island is located at Point Sal on the border of San Luis Obispo and Santa Barbara counties.

At Lion Rock during June and July 1971, the ratio of adult males to sub-adult California sea lions (sex unknown) was about one to five. The ratios of adult males to sub-adults during the non-breeding months were as follows: August 1971, one to one; September and October 1971, four to one; and December 1971 through April 1972, ten to one. Unfortunately it is very difficult to distinguish between young males and females. For this reason only general size and appearance were considered in making the count ratios. Most of the adult males seen throughout the year were estimated to be at least 5 years of age based upon the development of the sagittal crest (Schusterman and Gentry 1970). These animals frequently participated in mock territorial behavior as described by Peterson and Bartholomew (1967).

The high incidence of non-breeding but apparently sexually mature males during and just after the breeding season suggests that they may be in the last group to migrate south from northern islands such as Año Nuevo (Santa Cruz County). Very few *Zalophus* are seen on Año Nuevo Island during late June and July (Orr and Poulter 1965). However, Orr and Poulter (1965) have reported that a peak in the population at Año Nuevo Island occurs just after the breeding season in August and September. No dramatic changes in the numbers of in-

dividuals such as this was seen from May through September during my study.

Pupping is seldom seen on the islands, however, one pup (about 2 weeks old) was seen on our June 11, 1971 visit to Lion Rock. The animal appeared normal, sucking was observed. Peterson (1968) also observed the pairing of certain females and young but observed no sucking. He reported no breeding activity among the sea lions.

Three tagged California sea lions were observed at Lion Rock on June 11, 1971. One had a "silver" colored metal tag, and two animals had blue metal tags attached to one hind flipper. Identification of flipper position and tag number was not possible because of the compactness of gathered animals.

Several Steller sea lions were observed on Lion Rock. One adult male and two adult females were seen on July 16, 1971. On May 25, 1972, 11 were seen; 2 adult males, 5 adult females, and 4 sub-adults. No pups were observed. One adult male northern fur seal, *Callorhinus ursinus*, was seen amongst California sea lions on June 11, 1971 at Pecho Rock.

Harbor seals, *Phoca vitulina*, and northern elephant seals, *Mirounga augustirostris*, were not seen on any of the islands during the 1 year census. Harbor seals are abundant on rocky inlets and beaches along the coast of San Luis Obispo County. Only one elephant seal was seen along this coast during the 1970–1972 study and it was dead. According to local inhabitants elephant seals are seldom seen.

Bartholomew and Hubbs (1952), and Orr and Poulter (1965) have stated that male California sea lions migrate north after the breeding season on the Santa Barbara Channel islands, while females appear to migrate south. In reviewing the literature on the changes in the numbers of sea lions throughout a year for populations in British Columbia, Canada (Hancock 1970), at Año Nuevo Island (Peterson and Gentry 1967), and for the Santa Barbara Channel islands (Odell 1971) I feel that the addition of my findings confirm the notion of a northern migration. Confirmation can only come from a more detailed analysis of the sexes, however, in terms of the changes in the frequency of the numbers of sea lions along the coast throughout the year, the northern migration hypothesis of males appears correct.

The San Luis Obispo County population of *Z. californianus* remained relatively constant throughout the 1971 breeding season. These islands would appear to represent a convenient stop-off for sea lions migrating north and south. The islands undoubtedly act as peripheral hauling grounds only, substantiated by the lack of observed reproductive behavior and changes in the age composition of the population throughout the year.

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LITERATURE CITED

Bartholomew, G. A., and C. L. Hubbs. 1952. Winter population of pinnipeds about Guadelupe, San Benito, and Cedros islands, Baja California. J. Mammal. 33 : 160–171.

Bonnot, P. 1928. The sea lions of California. Calif. Fish Game 14(1) : 1–17.

Carlisle, J. G., Jr., and J. A. Aplin. 1971. Sea lion census for 1970, including counts of other California pinnipeds. Calif. Fish Game 57(2) : 124–126.

Hancock, D. 1970. California sea lion as a regular winter visitant off the British Columbia coast. J. Mammal. 51(3) : 614.

Odell, D. K. 1971. Censuses of pinnipeds breeding on the California channel islands. J. Mammal. 52(1) : 187–190.

Orr, R. T., and T. C. Poulter. 1965. The pinniped population of Año Nuevo Island, California. Proc. Calif. Acad. Sci. 4th. ser. 32(13) : 377–404.

Peterson, R. S. 1968. Observations of sea lions on Lion Rock, San Luis Obispo County, California, 1968. University of California, Santa Cruz.

Peterson, R. S., and G. A. Bartholomew. 1967. The natural history and behavior of the California sea lion. The American Society of Mammalogists. Special Publication No. 1. 79 pages.

Peterson, R. S., and R. L. Gentry. 1967.' Biological investigations in Año Nuevo State Reserve, 1966–1967. University of California, Santa Cruz.

Rowley, J. 1929. Life history of the sea lion on the California coast. J. Mammal. 10(1) : 1–36.

Schusterman, R. J., and R. L. Gentry. 1970. Development of a fatted male phenomena in California sea lions. Develop. Psychobio. 4(4) : 333–338.

Calif. Fish and Game, 60(2) : 84–87. 1974.

COYOTE SCATS AS AN INDICATOR OF TIME OF FAWN MORTALITY IN THE NORTH KINGS DEER HERD[1]

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Coyote scats were collected from the summer range and analyzed to determine diet remains by percent occurrence in 2 week intervals from June 1 to August 31, 1973. Occurrence of fawn remains in the scats corresponded to the fawn drop period, indicating the fawns are dying during or shortly after parturition. The decrease of fawn remains during late summer suggests little summer fawn mortality after the immediate post-natal period.

INTRODUCTION

Recent migratory deer (*Odocoileus hemionus californicus*) populations on the Sierra Nevada west slope are about 75% below early 1960 levels, according to California Department of Fish and Game surveys. The decrease has been attributed to a decrease in fawn survival. In the North Kings deer herd (sub-unit 13-D of Longhurst et al. 1952), in eastern Fresno County, California, winter fawn survival has decreased from an average 70 fawns per 100 does in the early 1960's to an average 30 fawns per 100 does in the early 1970's. The North Kings Deer Herd Management Plan (Winter et al. 1971) was implemented by the California Department of Fish and Game, the Sierra National Forest, the Pacific Southwest Forest and Range Experiment Station, and the Fresno County Sportsman's Club to determine the "when, where and why" of fawn mortality, and develop management techniques to reverse the population decline. This paper reports the results of coyote (*Canis latrans*) scat analysis by 2 week intervals from June 1, to August 31, 1973, as a method of determining the time of fawn mortality on the summer range.

METHODS

An initial range survey was made to determine suitable scat collection locations using the criteria, (i) relatively high deer use in the area, (ii) presence of old coyote scats indicating relatively high coyote density in the area, (iii) easy road access through the area. Three dirt road systems were used, east of Shaver Lake, northwest of Markwood Meadow, and the Swamp Lake Vehicle Way (Figure 1). Scats were collected weekly along these routes, and additional collections were made at random throughout the summer range. Scats collected from the three routes were known to have been dropped within 1 week. All other scats were aged by comparing them to scats of known drop date that were placed in exposed locations to "age". All scats were lumped by 2 week intervals to increase the sample size and minimize errors in estimating age.

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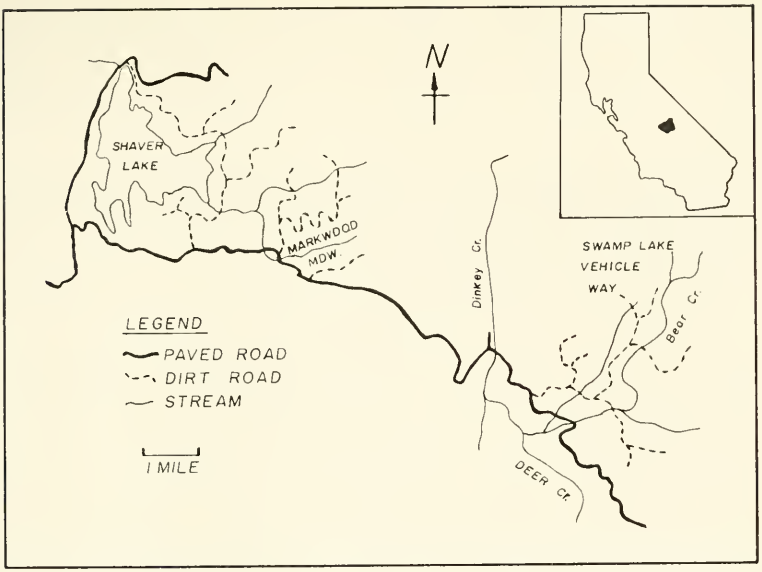

FIGURE 1. Map of coyote scat collection areas from the North Kings deer herd, Fresno County, California, 1973.

Scats were washed in detergent soap over window screen mesh to remove the fecal matrix from identifiable diet remains. The scat was air dried and diet remains were classified and percent abundance estimated in the categories, (i) rodents and rabbits, (ii) insects, (iii) vegetation, (iv) deer adult, (v) deer fawn, (vi) other.

RESULTS AND DISCUSSION

It long has been known that the coyote is an opportunistic feeder that will eat the most easily obtainable food. Thus the basic assumption was made that a dead fawn, whether scavenged or actually killed by the coyote, would appear in coyote scats shortly after death. The pattern of percent occurrence of fawn remains, chiefly hair, bones and hooves, in coyote scats therefore would reflect the pattern of fawn mortality. The analytical methods used indicate only time of fawn death and are not intended to imply predation as the cause of death.

The percent occurrence of diet items in the scats by 2 week intervals shows three distinct diet changes during the study period (Figure 2). Rodents and rabbits were replaced by fawns as the dominant diet item for a 6 week period from mid-June to late July. Vegetation, mainly gooseberries (*Ribes* sp.), manzanita (*Arctostaphylos* sp.) berries and grasses, became an important food source in August. Rodents and rabbits again became the major diet item in late August.

The fawn drop period begins in mid-June, peaks in early July and is essentially over by August. This period roughly corresponds with the pattern of fawn remains which occurred in coyote scats. Previous investigation has shown fawn production in the North Kings herd was about 140 fawns per 100 does at parturition, and that mortality occurred in two distinct periods (Salwasser 1972). Composition counts taken in September, when all fawns were at heel and prior to the fall

migration, indicated a 50% fawn loss on the summer range. December counts, after the migration, indicated another 50% loss of the fawns that survived the summer. It is not possible to infer the exact timing or cause of the second loss period, but it is clear from the coyote scat analysis that the first loss period occurred during or shortly after parturition.

There are three major possible causes of post partum fawn mortality, (i) predation, (ii) stillbirth or weak fawns due to inadequate nutrition of the pregnant doe, and, (iii) poor quality or quantity of milk due to inadequate diet of the lactating doe. Although it is impossible to rule out predation as the major cause of mortality, both low coyote and deer densities in the study area, and the excellent fawn cover provided by forest and brush habitats, would tend to minimize predation pressure on fawns. Verme's work (1962, 1963), on the effect of pregnant doe nutritional plane on fetal growth and fawn survival demonstrated increased post partum mortality from penned does on poor diets, with fawn mortality inversely correlated with size and weight of the fawn at birth. Salwasser (1972, p. 24) discussed late gestation nutrition as a factor in increased fawn mortality in the North Kings herd. The range used by deer during late gestation, mainly transitional yellow pine forest, has declined in both quality and quantity of forage available to deer. Preliminary fetal analysis indicated fawns may not attain optimum size or weight by birth. To date there is no information on milk quality or quantity from lactating does in the herd, but the weekly pattern of fawn remains in coyote scats strongly supports the

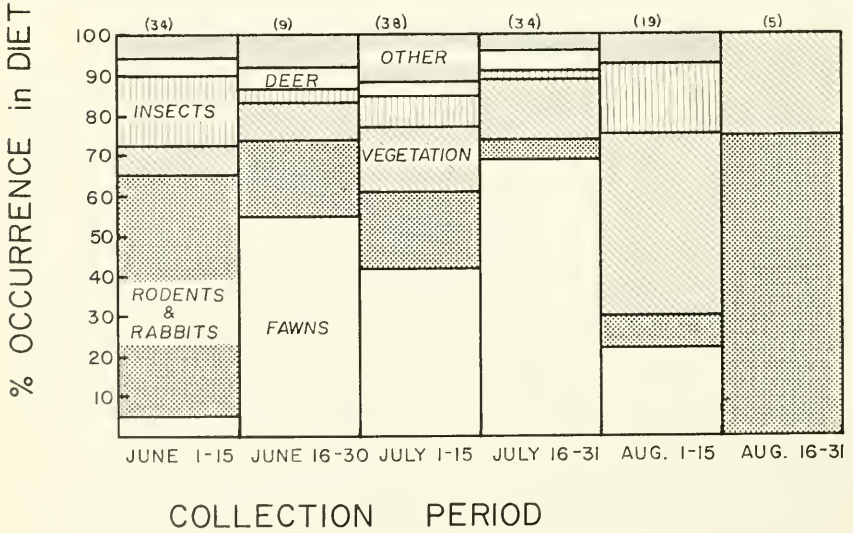

FIGURE 2. Percent occurrence of food items in coyote scats by 2 week intervals from June 1 to August 31, 1973, from the North Kings deer herd in Fresno County, California.

hypothesis that the early fawn loss period is due to the production of weak or stillborn fawns as the result of inadequate nutrition for the pregnant doe. The extent of coyote predation on healthy fawns is not known.

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LITERATURE CITED

Longhurst, W. M., A. S. Leopold, and R. F. Dasmann. 1952. A survey of California deer herds, their ranges and management problems. Calif. Dep. of Fish and Game, Game Bull. no. 6, 136 p.

Salwasser, H. J. 1972. North Kings deer herd: fawn production and survival study. Calif. Dep. of Fish and Game, Admin. Rep. PR W-5-R-17, 24 p.

Verme, L. J. 1962. Mortality of white-tailed deer fawns in relation to nutrition. In Proc. Natl. White-Tailed Deer Disease Symp. I. Univ. Georgia, Athens.

———. 1963. Effect of nutrition on growth of white-tailed deer fawns. Trans. N. Am. Wildl. and Nat. Resources Conf. 28: 431–4431.

Winter, F. A., G. Ashcraft, and B. Stewart. 1971. North Kings deer herd management plan. U. S. Dep. Agr. 44 p.

Calif. Fish and Game, 60(2) : 88–90. 1974.

AN EVALUATION OF TWO ARTIFICIAL LEAST TERN NESTING SITES[1]

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A one third acre nest site and 70 individual nest mounds, all constructed of sand, were developed and tested on the marginal substrate of a large salt flat.

Thirty-four nests were discovered on the large site; two nests were found on the nest mounds. The nest density on the one third acre site was the highest yet recorded for the California least tern.

INTRODUCTION

The California least tern (*Sterna albifrons browni*) historically nested on beaches near estuaries from Moss Landing, Monterey County to Southern Baja California, Mexico (Massey 1972). Recently, its population has decreased rapidly as a result of unrelenting human disturbance and development on the tern's nest sites (Craig 1971). The population has been reduced so drastically that it was declared endangered by the Secretary of the Interior (Hickel 1969) and by the California Fish and Game Commission (1971).

To determine the status of the least tern at the Camp Pendleton Marine Corps Base in San Diego County, and to recommend methods of protection and habitat improvement, a nest study has been conducted since 1971. Four nest sites were studied, two on beaches, and two on a large salt flat. The salt flat sites have been severely affected by past spring rains. Nest flooding and subsequent abandonment was caused by the inability of the clay silt soils of the salt flats to infiltrate water (Swickard 1972). This paper describes the results of an attempt to improve nesting success by establishing two artificial beach type nest situations on a salt flat environment.

METHODS

On 23 April 1973 sand was excavated from an area near a beach nest site and deposited on a secondary nest site in the salt flats. The sand was about 2 ft (.61 m) deep and covered an area 70 x 170 ft (21.3 m x 51.8 m). The excavation and deposition eliminated surface vegetation and sand solidification. The site's relative isolation minimized human disturbance. The intended result was a duplication of optimum beach nesting conditions.

Fifty individual nest mounds were established at 10 ft (3.05 m) intervals in five rows east of the large artificial site (Fig. 1). Twenty more mounds were established south of the large artificial site, 20 ft (6.1 m) apart in two rows. Each sand mound was approximately 2 ft in diameter and 3 inches (7.6 cm) thick.

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FIGURE 1. Tern nest sites constructed by placing sand on salt flat. In the foreground are the individual nest sites. Photo official U.S. Marine Corps by Deane Swickard.

RESULTS

Thirty four nests were found on the large artificial nest site, seven of which were discovered along the fringe of the site where the wind had blown sand beyond the original site boundaries.

The first nest was discovered on May 15, 22 days after site development and by May 29, 30 nests were present. The last four nests were found between May 29 and June 12.

Based on the corrected site size of 80 x 180 ft (24.4 m x 54.9 m) the nest density on the artificial site was 102 nests per acre. This exceeds the highest previously recorded nest densities of 15–18 nests per acre at the Camp Pendleton nest sites and greatly exceeds all nest densities calculated from Craig's report (1971) on a statewide survey of least tern nest sites.

The average clutch size was 2.09 on the one third acre site, slightly higher than the 1.99 average clutch size of the beach sites. Seventy one eggs were laid, 40 eggs hatched, 30 eggs were destroyed by predators and one egg was abandoned. The hatching success was 57%.

Two nests, each containing two eggs, were found on the nest mounds though evidence of nest building was present on all mounds. The eggs in one nest were destroyed by predators; the eggs in the other nest hatched.

DISCUSSION

The acceptance and resultant nest density is indicative of the suitability and potential management value of such artificial sites.

Though hatching success was reduced by predation this occurred because the sand spit at the mouth of the Santa Margarita River was breeched. This unusual condition drained several channels that normally act as moats along three sides of the nest site. Similar predation occurred on one of the natural beach nest sites. Futher losses were eliminated by predation control measures. In spite of the predation, hatching success exceeded the 53.5% of the salt flats in 1971 when

rains caused massive nest abandonment. In the absence of the unusual predation, hatching success is expected to consistently compare with those of the natural beach sites which are 72–95%.

The individual nest mounds were a potentially economical means of providing suitable nest habitat. Near total rejection of these indicates the tern's preference for larger sand areas.

CONCLUSIONS

As the quantity of suitable least tern nest habitat is further reduced the quality of the remaining habitat must be improved. The effective technique described here has potential application where the nest substrate is marginal or unsatisfactory but where other nest requirements are adequate.

ACKNOWLEDGMENTS

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LITERATURE CITED

Calif. Fish and Game Comm. 1971. Animals of California declared to be rare or endangered. Additions to Title 14, Calif. Admin. Code of May 21, 1971.

Craig, Alan M. 1971. Survey of California least tern nesting sites. Calif. Dep. of Fish and Game, unpublished, 112 p.

Hickel, Walter G. 1969. Endangered species of native fish and wildlife. Sec. of the Int. list of native fish and wildlife threatened with extinction in accordance with Sec. 1(c) of Endangered Species Preservation Act of Oct. 15, 1966.

Massey, Barbara W. 1971. A breeding study of the California least tern. Calif. Dep. of Fish and Game, Wildl. Manage. Branch, Admin. Rep. No. 71-9.

Swickard, Deane K. 1972. Status of the California least tern at Camp Pendleton, California. California Birds 3 (3) : 49–58.

Calif. Fish and Game, 60(2) : 91–101. 1974.

NOTES

GIANT SQUIDS, *ARCHITEUTHIS* SP., FROM STOMACHS OF SPERM WHALES CAPTURED OFF CALIFORNIA

Although the giant squid, *Architeuthis*, is widespread in temperate seas in the Pacific Ocean, it has heretofore been found in adult or near-adult size only on the western side—near the Kuril Islands, Japan, Australia, and New Zealand (M. R. Clarke 1966). Roper and Young (1972) have identified a juvenile *Architeuthis* (45 mm mantle length) from the eastern Pacific off Chili, and Pinkas, Oliphant, and Iverson (1971) list a specimen, doubtless a juvenile, taken from the stomach of an albacore which was caught off California. This note describes the first recovery and identification of adult or near-adult sized mandibles of *Architeuthis* from the eastern Pacific Ocean.

Mandibles of the giant squid *Architeuthis* sp. were found in the stomachs of 12 of 552 sperm whales (*Physeter catodon*) that Rice and his assistants examined at the Del Monte and Golden Gate whaling stations in Richmond, California, from 1959 through 1970. The 12 sperm whales that contained the mandibles had been collected over the continental slope in water 1,100–3,700 m deep from lat 36°55′N to 38°05′N, and from long 123°09′W to 124°00′W. Months of collection (and number of whales containing mandibles) were: February (1), April (2), May (1), June (2), September (1), October (1), November (2), and December (2). Four of the whales were females (9.0–11.0 m TL), three sexually immature or pubertal males (8.5–11.0 m TL) from breeding schools, and five were older males (11.0–12.5 m TL) that were solitary or in bachelor schools.

The *Architeuthis* mandibles were identified by Fiscus on the basis of published descriptions and figures by Verrill (1882), M. R. Clarke (1962b), and Akimushkin (1963). M. C. Mercer (Fisheries Research Board of Canada Biological Station, St. Johns, Nfld.) and F. A. Aldrich (Memorial University of Newfoundland, St. Johns, Nfld.) confirmed the identification by comparing some of our beaks with North Atlantic specimens of *Architeuthis*. Measurements and a description (after Clarke 1962b) of the mandibles (Figure 1) are: dorsal—length of rostrum 10 mm, crest (overall) length 56 mm; ventral—length of rostrum 10 mm, crest length 30 mm. The crest of the dorsal mandible is darkened and the lateral walls are transparent except for a small isolated dark patch. The crest and lateral walls of the ventral mandible are darkened and the wings which are transparent at this stage have a small isolated dark patch.

Ventral mandibles appear to be more fragile than dorsal mandibles; the one we have illustrated (Figure 1) was the only complete ventral mandible obtained. Fragmentary remains of five other ventral mandibles with rostral lengths from 12 to over 30 mm were identified. Nine dorsal mandibles, in addition to the one shown, were identified; four of these with rostral lengths from 10 to 15 mm displayed the same

degree of darkening as the illustrated beak, while three with rostral lengths from 11 to 15 mm displayed a greater degree of darkening of the lateral walls. Two of the dorsal mandible fragments could not be measured; these accompanied the ventral beak fragments whose rostral length exceeded 30 mm.

Many species of this genus have been described, mostly from fragmentary specimens; until the extent of intraspecific variation has been determined it is misleading to apply specific names to specimens (M. R. Clarke 1962a).

The distribution, life history, and ecology of *Architeuthis* have been succinctly summarized by M. R. Clarke (1966).

Off California, sperm whales may eat *Architeuthis* more often than our records indicate. It was not possible to collect all the squid mandibles found in the whale stomachs, and *Architeuthis* mandibles could be overlooked among remains of *Moroteuthis robusta*, another "giant" species (although smaller than *Architeuthis*) that is the predominant food of sperm whales off California. *Architeuthis* remains were found in the stomachs of 16% of 1,141 sperm whales taken near the Kuril Islands (Betesheva 1961), and in the stomachs of some sperm whales taken in the Bering Sea from the region of the Commander Islands and north of the western Aleutian Islands, east to Amukta Pass (Kodolov 1970), but none were found in the Gulf of Alaska (Okutani and Nemoto 1964) or off British Columbia (Pike 1950). Elsewhere in the world, *Architeuthis* has been found in the stomachs of sperm whales from New Zealand (Gaskin and Cawthorne 1967; Dell 1970), South Africa (M. R. Clarke 1966), Madeira (M. R. Clarke 1962a), the Azores (R. Clarke 1955, 1956), Ireland (Hamilton 1914), and the southern Indian Ocean (Berzin 1971). Korabel'nikov's (1959) alleged records from Antarctic sperm whales require confirmation, according to M. R. Clarke (1966).

We wish to thank Clyde F. E. Roper, Division of Mollusks, Smithsonian Institution, Washington, D.C., for his review of the manuscript, and Leo Pinkas, California State Fisheries Laboratory, Long Beach, Calif., for additional information on his specimen.

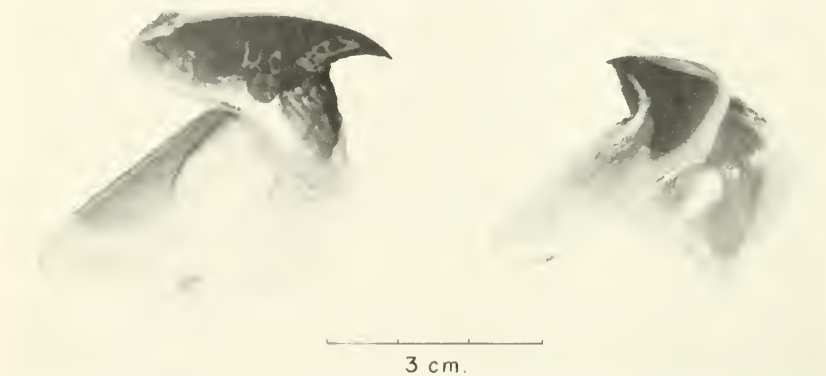

FIGURE 1. *Architeuthis* sp. mandibles, lateral view; left—dorsal mandible, right—ventral mandible, specimen number R-1967-128. Photograph by Ian B. MacAskie, Fish. Res. Bd. of Canada, Biological Station, Nanaimo, B.C.

REFERENCES

Akimushkin, I. I. 1963. Golovonogie mollyuski morei SSSR (Cephalopods of the seas of the USSR). Izd. Akad. Nauk SSSR, Moscow. 236 p. (Translation, 1965, Israel Program Sci. Transl., Jerusalem, 223 p. avail. Natl. Tech. Inf. Serv., Springfield, Va., as TT 65-50013.)

Berzin, A. A. 1971. Kashalot (The sperm whale). Izd. Pishch. Prom., Moskva. (Translation, 1972, Israel Program Sci. Transl., Jerusalem, 394 p. avail. Natl. Tech. Inf. Serv., Springfield, Va., as TT 71-50152.)

Betesheva, E. I. 1961. Pitanie promyslovykh kitov Prikuril'skogo raiona (Food of commercial whales in the Prikuril region). Akad. Nauk SSSR, Tr. Inst. Morfol. Zhivotn. 35 : 7–32.

Clarke, M. R. 1962a. Stomach contents of a sperm whale caught off Madeira in 1959. Norsk Hvalfangst-Tid. 51 : 173–191.

——— 1962m. The identification of cephalopod "beaks" and the relationship between beak size and total body weight. Bull. Brit. Mus. (Nat. Hist.), Zool. 8(10) : 419–480.

——— 1966. A review of the systematics and ecology of oceanic squids. Adv. Mar. Biol. 4 : 91–300.

Clarke, R. 1955. A giant squid swallowed by a sperm whale. Norsk Hvalfangst-Tid. 44 : 589–593.

——— 1956. Sperm whales of the Azores. "Discovery" Rep. 28 : 237–298.

Dell, R. K. 1970. A specimen of the giant squid *Architeuthis* from New Zealand. Rec. Dominion Mus. Wellington 7(4) : 25–36.

Gaskin, D. E., and M. W. Cawthorne. 1967. Squid mandibles from the stomachs of sperm whales (*Physeter catodon* L.) captured in the Cook Strait region of New Zealand. N.Z. J. Mar. Freshwater Res. 1(1) :59–70.

Hamilton, J. E. 1914. Report of the committee appointed to investigate the biological problems incidental to the Belmullet whaling station. Rep. Brit. Assoc. Adv. Sci. 84 : 125–161.

Kodolov, L. S. 1970. O kal'marakh v Beringovom more (Squids of the Bering Sea). Tr. Vses. Nauchn.-issled. Inst. Morsk. Rybn. Khoz. Okeanogr. 70 (Izv. Tikhookean. Nauchn.-issled. Inst. Rybn. Khoz. Okeanogr. 73) :162–165. Transl. in P. A. Moiseev, Editor. Soviet Fisheries Investigations in the northeastern Pacific, Part V : 157–160, translated by Israel Program Sci. Transl., 1972, avail. Natl. Tech. Inf. Serv., Springfield, Va. as TT 71-50127.)

Korabel'nikov, L. V. 1959. O pitanii kashalotov v Antarkticheskikh moryakh (Food of sperm whales in the Antarctic seas). Priroda 48(3) : 103–104.

Okutani, T., and T. Nemoto. 1964. Squids as the food of sperm whales in the Bering Sea and Gulf of Alaska. Sci. Rep. Whales Res. Inst. 18 :111–121.

Pike, G. C. 1950. Stomach contents of whales caught off the coast of British Columbia. Fish. Res. Bd. Can., Progr. Rep. Pac. Coast Stn. 83 :27–28.

Pinkas, L., M. S. Oliphant, and I. L. K. Iverson. 1971. Food habits of albacore, bluefin tuna, and bonito in California waters. Calif. Dep. Fish and Game, Fish Bull. 152, 105 p.

Roper, C. F. E., and R. E. Young. 1972. First records of juvenile giant squid, *Architeuthis* (Cephalopoda : Oegopsida). Proc. Biol. Soc. Wash. 85(16) : 205–222.

Verrill, A. E. 1882. Report on the cephalopods of the northeastern coast of America. Rep. U. S. Comm. Fish. and Fish., Pt. 7, Rep. Comm. 1879 :211–450, 46 pl.

—Clifford H. Fiscus and Dale W. Rice, National Marine Fisheries Service, Marine Mammal Division, Naval Support Activity, Bldg. 192, Seattle, WA 98115. *Accepted for publication November 1973.*

AGE AND GROWTH OF LARGEMOUTH BASS IN CALIFORNIA FARM PONDS

The largemouth bass, *Micropterus salmoides* (Lacépède), is the principal predator and premium game fish in most new and reclaimed waters in the state. It has long been recommended for stocking California warmwater farm ponds. The Department of Fish and Game provides largemouth bass on a limited basis to qualified pond owners for stocking in private waters.

While numerous age and growth studies have been published on largemouth bass in California waters and in farm ponds in other states, we know of no studies of this species in the California farm pond environment, which consists of over 21,000 ponds. This paper reports on the age composition, growth, length-weight relationship, and condition of the largemouth bass in three Central Valley farm ponds containing established populations of bass and forage species. These ponds are located east of Sacramento in the western foothills of the central Sierra Nevada at elevations of 80 to 213 m above sea level. Applegate Pond (14.5 hectares) contained the most diverse fish population, consisting of largemouth bass, green sunfish (*Lepomis cyanellus* Rafinesque), golden shiner (*Notemigonus crysoleucas* Mitchill), mosquitofish (*Gambusia affinis* Baird and Girard), carp (*Cyprinus carpio* L.), and Sacramento sucker (*Catostomus occidentalis* Ayres). Reuter Pond (0.8 hectare) contained bass, redear sunfish (*Lepomis microlophus* Günther), and mosquitofish. Potter Pond (1.0 hectare) contained bass, redear sunfish, bluegill (*Lepomis macrochirus* Rafinesque), and mosquitofish. These ponds were representative of most farm ponds in central California in that aquatic vegetation was abundant, fishing pressure was light, and the pond owners expended little management effort. Shoreline seining and examination of angler's catches indicated that all three populations were in a "balanced" condition (Swingle 1956).

MATERIALS AND METHODS

Fish populations were sampled periodically from March 1970 through July 1971. Nearly all younger bass were captured with 25- and 50-ft bag seines, while most older bass were taken with hook and line. Lengths (standard, fork, and total) were recorded to the nearest millimeter, and weight was recorded to the nearest gram. Scale samples were taken from the area below the lateral line at the tip of the pectoral fin. Scales from fish less than 200 mm FL were mounted between glass slides, while scales from larger bass were impressed on cellulose acetate using a heated press. All age determinations were made with a Bausch and Lomb microprojector at a magnification of 90×. A total of 282 fish were aged by counting annuli. The main criterion for annulus recognition was "cutting over" of circuli in the lateral fields. The anterior scale radius and the distance from the focus to each annulus was measured to the nearest millimeter using a ruled strip of paper.

AGE AND GROWTH

All results are expressed in fork length. Conversion factors for converting fork length (FL) to standard length (SL) and total length (TL) were computed by the least squares method for fish from all three ponds combined:

$$SL = -1.7 + 0.861\ FL$$
$$TL = 1.6 + 1.034\ FL$$

The relationship between fork length and the anterior scale radius (90×) was determined by the least squares method, and computed separately for each population:

Applegate: $L = 16.615 + 0.699\ (S)$
Potter: $L = 23.292 + 0.648\ (S)$
Reuter: $L = 19.023 + 0.678\ (S)$

The mean back-calculated lengths were compiled for the three populations with the sexes combined, since no significant difference between the sexes was apparent. The greatest growth increments occurred in the first or second year of life, followed by a general decrease in increments in successive years (Table 1). Calculated lengths at the various annuli were generally greatest for Applegate Pond and lowest for Potter Pond, with the Reuter Pond bass being intermediate. Lee's phenomenon was not apparent. The criteria presented by Hile (1941) were used to validate annulus interpretation. In general, bass in these ponds grew faster than bass in studies from larger reservoirs in California (Beland 1954, Kimsey and Bell 1955, LaFaunce, Kimsey, and Chadwick 1964, Tharratt 1966, Miller 1971).

The time of annulus formation was determined from bass collections taken from March 6 through April 3, 1970, and February 28 through April 18, 1971. Only one of the three bass taken in the February 28 collection had formed a new annulus, but 37 of the 40 bass collected in March, and all of the 18 bass collected in April had formed the current year's annulus.

TABLE 1. **Mean Calculated Fork Lengths and Annual Calculated Increments (mm) of Largemouth Bass in Three California Farm Ponds, 1970–71.**

Pond	Year of life				
	1	2	3	4	5
Applegate					
Mean calculated length	145	267	351	434	494
Mean annual increment	145	122	84	83	60
Number of fish	111	22	5	2	1
Potter					
Mean calculated length	120	244	327		
Mean annual increment	120	124	83		
Number of fish	65	47	13		
Reuter					
Mean calculated length	126	268	339	382	
Mean annual increment	126	142	71	43	
Number of fish	106	44	17	4	

LENGTH-WEIGHT RELATIONSHIP AND CONDITION

Since no significant difference in length-weight relationship was apparent between the sexes, the sexes were combined and the length-weight relationship was computed separately for each population:

Applegate ($N = 357$): $\log W = -4.792 + 2.983 \log L$
Potter ($N = 93$): $\log W = -4.723 + 2.932 \log L$
Reuter ($N = 359$): $\log W = -4.967 + 3.062 \log L$

The length-weight relationships of the bass from Potter and Reuter ponds differed the greatest, but an analysis of covariance for difference of slope and difference of levels indicated that the difference was not statistically significant at the 0.05 level.

Overall mean condition factors (K_{FL}) for the three populations were as follows: Applegate and Reuter, 1.47; Potter, 1.45. No major trend in coefficient of condition with increase in length was evident, and there was no pronounced seasonal change in condition.

ACKNOWLEDGMENTS

This paper is based on a thesis written in partial fulfillment of requirements for the degree of Master of Science at California State University, Sacramento. We express gratitude to the following individuals: Ralph Carpenter, California Department of Fish and Game, for assistance in computer programming and statistical treatment of the data; the owners of the study ponds for allowing us unlimited access; numerous students at California State University, Sacramento for field assistance; and Carolyn Schultze, for field assistance and typing the manuscript.

REFERENCES

Beland, Richard D. 1954. Report on the fishery of the lower Colorado River. The Lake Havasu fishery. Calif. Dep. Fish and Game, Inland Fish. Admin. Rep. 54–17:42p. (mimeo).

Hile, Ralph. 1941. Age and growth of the rock bass, *Ambloplites rupestris* (Rafinesque), in Nebish Lake, Wisconsin. Trans. Wisc. Acad. Sci., Arts and Let. 33:189–337.

Kimsey, J. B., and R. R. Bell. 1955. Observations on the ecology of the large-mouth black bass and the tui chub in Big Sage Reservoir, Modoc County. Calif. Dep. Fish and Game, Inland Fish. Admin. Rep. 55-15: 17 p. (mimeo).

LaFaunce, Don A., J. B. Kimsey, and Harold K. Chadwick. 1964. The fishery at Sutherland Reservoir, San Diego County, California. Calif. Fish Game 50(4): 271–291.

Miller, Edward E. 1971. The age and growth of centrarchid fishes in Millerton and Pine Flat reservoirs, California. Calif. Dep. Fish and Game, Inland Fish. Admin. Rep. 71–4:17p. (mimeo).

Swingle, H. S. 1956. Determination of balance in farm fish ponds. Trans. N. A. Wildl. Conf. 21:298–318.

Tharratt, Robert C. 1966. The age and growth of centrarchid fishes in Folsom Lake, California. Calif. Fish Game 52(1): 4–16.

—*Ronald F. Schultze, U.S.D.A. Soil Conservation Service, Sacramento, California, 95814 and C. David Vanicek, Department of Biological Sciences, California State University, Sacramento, California 95819.*
Accepted October 1973.

A WHEELED DEVICE FOR SAMPLING THE BIOTA OF A CONCRETE-LINED CANAL

The Bureau of Reclamation, together with its contracted agency, the California Academy of Sciences, is attempting to find a means of controlling the infestation of the Delta-Mendota Canal by the Asiatic clam *Corbicula* sp. and the amphipod *Corophium spinicorne*. The 116-mile (187 km) canal, located in California's San Joaquin Valley, has to be drained and mechanically cleaned approximately every 3 years due to the flow reduction caused by the accumulation of clams and amphipods. After each successive cleaning, these organisms become re-established. The clam beds are often 3 ft (.914 m) deep and several hundred feet long. As many as 1,000 clams have been counted in a square foot (.092 m^2) of sediment. The amphipods, which make and occupy mucous lined tubules, are found on the side slopes of the canal. In the first 20 miles (32 km) of the canal, the amphipod matting covers the entire slope to a depth of 1 inch (2.5 cm) or more. The matting is usually associated with the bryozoan *Fredericella sultana* or the hydrozoan *Cordylophora lacustris*. Amphipods attain densities of up to 10,000 per square foot of side-slope material.

In the summer of 1972, an extensive investigation of the ecology of the Delta-Mendota Canal was initiated. One of the first problems encountered was finding a piece of equipment suitable for sampling the concrete slopes of the canal. Because of the angle of the slope and the depth and velocity of the water, conventional samplers were unsatisfactory. A new sampler was designed and built by the Bureau of Reclamation.

The slope sampler was needed to take quantitative samples at varying depths down the slope and to retrieve the material to the surface in good condition. The sampler consists of a removable steel sampling box (Figure 1) mounted on a wheeled carriage. The sampling box has a plexiglass top for ease in determining sample size and composition before opening the box. A spring loaded trap door is located at the extreme forward edge of the sample box. This insures that all of the sample taken remains within the box. The wide track stance of the carriage in conjunction with the thin wheels prevent sluffing of the slope material which would invalidate the samples. The wide stance also adds stability to the vehicle in the fast current of the canal. The height between the bottom of the sample box and the ground was designed to provide an optimum cutting angle on the sampled material. Almost the entire sampler is constructed of ⅛-inch steel and weighs approximately 18 lb (8.2 kg). The total cost for construction is less than $100.

The sampler is lowered into the canal by means of a cable attached to the front (Figure 2). When the sampler reaches the appropriate depth, a line is pulled which drops the sampling box into position. The sampler is pulled up the slope the desired distance and a second line is pulled, releasing the trap door and enclosing all of the sampled

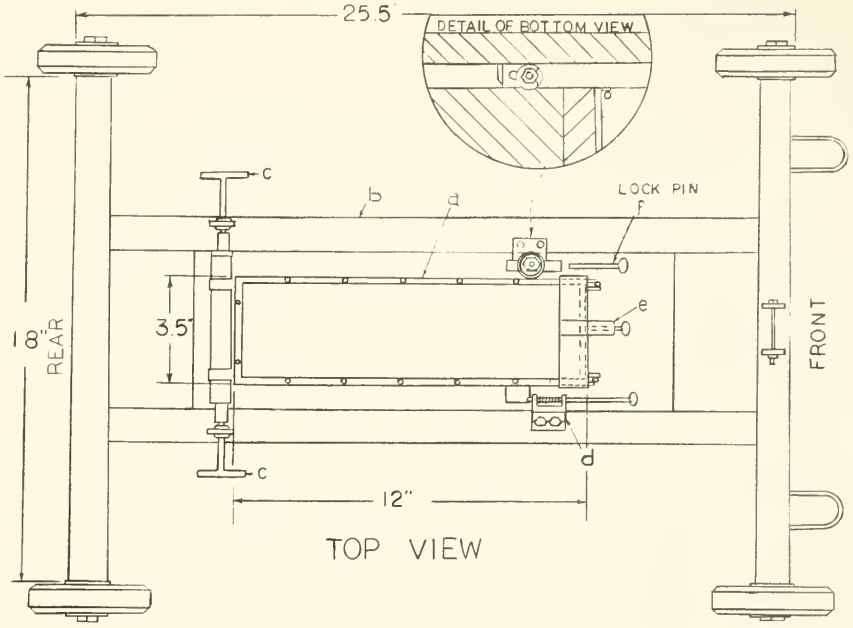

FIGURE 1. The sampler consists of a steel sampling box (a) and a wheeled carriage (b). The sampling box is held in place by two screw pivots (c) which allow it to be lowered to and raised from the sampled surface. Pin (d) allows the sample box to fall into the sampling position. After pulling the sampler forward the desired amount, pin (e) is released and the spring loaded trap door encloses the sampled material. Pulling pin (f) activates a coiled spring and plunger which raises the samples box off the concrete and thus allows the vehicle to be easily pulled to the surface. Diagram by Hamm Crocker.

FIGURE 2. Slope sampler being lowered into the Delta-Mendota Canal. The sampler is controlled from the surface by means of the attached lines. Photo by Dave Behrens of the California Academy of Sciences.

material within the box. A third line is pulled and the box is lifted, by the use of a spring and piston mechanism, off of the concrete slope. This prevents the sample box from being dragged up the slope, forcing additional material into the sample. It also prevents the blade of the box from catching in cracks in the concrete. The slope sampler is then hauled to the surface where pivots are unscrewed and the box is removed from the carriage. The sampled material can be easily removed and placed in containers.

The slope sampler has been used continuously for over a year and has been found to be accurate, easily handled, and relatively maintenance-free.

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Accepted November 1973.

OCCURRENCE OF THE TIGER BARB, *BARBUS TETRAZONA*, IN THE OWENS VALLEY, CALIFORNIA

The tiger barb, *Barbus tetrazona* Bleeker, is naturally distributed in waters of Sumatra, Borneo, and possibly Thailand (Sterba 1966); it has been imported into this country for years for sale to aquarists. Often the fish is very aggressive, and in aquaria it is usually kept segregated from other species. Maximum sizes appear to be near 7 cm (Frank 1969).

In the Southwest many endemic species of fish are localized in springs and isolated streams. Introduction of exotic fishes into these unique ecosystems has in the past been disastrous (Hubbs and Deacon 1964; Deacon, Hubbs, and Zahuranec 1964; Miller 1972; Minckley 1973). It is possible that some tropical fish introductions into warm desert springs are by fish dealers for use as brood ponds and one case of which we are aware has been documented (Minckley 1973). Whatever the source of these introductions they severely disrupt natural spring ecosystems and the native fishes they might contain. Such practices are strongly discouraged and in most states are illegal.

Two mature tiger barbs (ASU-6239) were collected on July 6, 1973 in the small stream flowing from Warm Springs Sanctuary in Owens Valley, Inyo County, California. This Sanctuary contains the rare Owens pupfish, *Cyprinodon radiosus* Miller. No specimens of *Barbus tetrazona* were collected or observed within the Sanctuary, but their close proximity prompts this note. Mosquitofish, *Gambusia affinis* (Baird and Girard), has already appeared in the Sanctuary since the Owens pupfish was first introduced in 1970 (Miller and Pister 1971; Miller 1972). There is an effective barrier present to prevent fish from moving upstream into the Sanctuary.

Specimens collected were both 37 mm (SL) and in breeding condition. One was a male and the other a female, both mature, with well developed gonads. Spawning by this species usually takes place at 24–28C (Frank 1969), and water of the Sanctuary and the outflow remains near 30C during most of the year. The habitat is nearly ideal for spawning to occur.

On the basis of collected specimens it appears that *Barbus tetrazona* may already be established just below the Warm Springs Sanctuary. If introduced and established in the Sanctuary it could have adverse effects on the pupfish population. This locality contains one of only two known populations of *Cyprinodon radiosus*.

ACKNOWLEDGMENTS

We wish to thank Dr. Shelby D. Gerking, Arizona State University, who helped collect the fishes. Dr. W. L. Minckley, Arizona State University, read the manuscript and offered helpful suggestions. This work is supported by a grant from the National Science Foundation (GB-32811) to R. J. Naiman.

REFERENCES

Deacon, J. E., C. Hubbs, and B. J. Zahuranec. 1964. Some effects of introduced fishes on the native fish fauna of Southern Nevada. Copeia 1964: 384–388.

Frank, S. 1969. The pictorial encyclopedia of fishes. Hamlyn Publ. Group Ltd. London. 552 p.

Hubbs, C. and J. E. Deacon. 1964. Additional introductions of tropical fishes into Southern Nevada. Southwest. Nat. 9: 249–251.

Miller, R. R. 1972. Threatened freshwater fishes of the United States. Trans. Amer. Fish. Soc. 101(2): 239–252.

Miller, R. R., and E. P. Pister. 1971. Management of the Owens pupfish, *Cyprinodon radiosus*, in Mono County, California. Trans. Amer. Fish. Soc. 100(3): 502–509.

Minckley, W. L. 1973. Fishes of Arizona. Arizona Game and Fish Department. Phoenix. 293 p.

Sterba, G. 1966. Freshwater fishes of the world. The Pet Library Ltd. New York. 877 p.

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BOOK REVIEWS

Antarctic Cirripedia

By William A. Newman and Arnold Ross, American Geophysical Union, January 29, 1971, 257 p. 48 plates, 90 text figures.

Antarctic Cirripedia is the 14th volume produced under the auspices of the Antarctic Research Series of the National Science Foundation. It is the first comprehensive treatment of the fossil and contemporary barnacles which occur south of the Antarctic Convergence (50°–60° S. latitude). The work is based primarily on specimens collected by the USNS ELTANIN, but samples from earlier expeditions, such as the historic Challenger and Discovery Cruises, have been included in the study.

As the title indicates, this book would attract and find primary use by the zoological specialist. However, this finely done monograph also has sections valuable to the zoological generalist interested in problems of bio- and paleogeography, evolution, taxonomy and cirriped anatomy and morphology. For beginning students interested in taxonomy of cirripeds, the materials and methods section is excellent in describing not only dissection techniques but also the new and not-yet-widely-known method for obtaining thin sections of balanomorphan shells.

All in all, this is an excellent work done, as the excruciatingly detailed line drawings in the systematics section bear witness, with the thoroughness of scholarship and attention to minute detail—things all works should aspire to.—*Laurence L. Laurant.*

FAO Catalogue of Fishing Gear Designs

Prepared by Fishing Gear and Methods Branch, Fishery Industries Division, Department of Fisheries, Food and Agriculture Organization of the United Nations; Fishing News (Books) Ltd., London, England, 1972; 155 p., illus.

This catalogue of commercial fishing gear designs is an updated revision and expansion of the original published in 1965. The designs presented in this book are of proven efficiency for particular species and areas. Plans are presented in a standard international systematic method and are of sufficient detail to enable one to construct a nearly exact replica. Designs also include the species fished, user country, region, and vessel size requirements.

A working knowledge of netmaking is necessary to interpret and comprehend the trawl and seine designs. Translation of the international standard method of design presentation into familiar terms used in the U.S.A. is somewhat bothersome and time-consuming.

Over two-thirds of the book is devoted to trawl designs. A large proportion of these trawls are of European design with the major trawling nations, except Russia, well represented. Only a few American and Asian designs are presented. Most trawls are intended for catching groundfishes and shrimp; however several designs of midwater trawls for pelagic species are included.

Roundhaul seines and a variety of other gears including gillnets, liftnets, longlines, trolling gear, dredges, and traps constitute the remainder of the book.

This catalogue is probably most useful as a general reference in designing fishing gear for a particular species or area. The fact that gear designs presented in this book are successful for certain species and conditions may serve as a guideline for developing gear to catch other similar species.—*Kenneth F. Mais.*

The Palinurid and Scyllarid Lobster Larvae of the Tropical Eastern Pacific and Their Distribution as Related to the Prevailing Hydrography

By Martin W. Johnson; University of California Press, Berkeley, Los Angeles and London, 1971; 41 p., illus.

In this paper, the author applies some of the methods of his 1960 study of the larvae of the California spiny lobster to larvae of more southerly spiny and slipper lobsters—charts show positions of various larval stages of the different species which occurred in the Eastern Tropical Pacific and Scripps Tuna Oceanography Research plankton hauls. As with those of the California spiny lobster, the larvae carried far

offshore are lost to the parent populations. Water current eddies around islands are apparently important for adult recruitment. The drift of the larval stages confirm current patterns determined in other ways.

There are figures of late larval stages and a key to separate those stages of *Panulirus interruptus, P. penicillatus, P. gracilis, P. inflatus, Evibacus princeps* and *Scyllasides astori.—Richard L. Moe.*

In Search of Trout

By Peter Barrett; Prentice-Hall, Inc. Englewood Cliffs, N.J., 1973; 223 p. Illustrated with black and white photos. $7.95.

The fly leaf of "In Search of Trout" indicates that the book is full of tips and advice on reading water, casting, currents, live bait, etc. and it is. It is not a "how-to" book with diagrams and drawings, but a book of well-written and enjoyable stories about Mr. Barrett's fishing experiences. Most of the stories are about fly fishing, although several talk about bait fishing. Lakes, small brooks, rivers; eastern and western U.S. and British Columbia; dry fly, nymphs, and streamers—all are found in one story or another. All of the stories have been published previously, either in *True*, where Mr. Barrett is Outdoors Editor, or in *Field and Stream;* readers of these magazines may find one or more of the stories familiar.—*K. A. Hashagen, Jr.*

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Notice is hereby given that the Fish and Game Commission shall meet on April 5, 1974, at 9:00 a.m. in the Auditorium of the Resources Building, 1416 Ninth Street, Sacramento, California, to receive recommendations from its own officers and employees, from the Department of Fish and Game and other public agencies, from organizations of private citizens, and from any interested persons as to what, if any, orders should be made relating to mammals, or any species or variety thereof for the 1974 hunting season.

Notice is hereby given that the Fish and Game Commission shall meet at 9:00 a.m. on May 3, 1974, in the Auditorium of the San Diego Gas and Electric Company, 101 Ash Street, San Diego, California, for public discussion of and presentation of objections to, the proposals presented to the Commission on April 5, 1974, and after consideration of such discussion and objections the Commission shall publicly announce the regulations it proposes to make relating to mammals, or any species or variety thereof, for the 1974 hunting season.

Notice is hereby given that the Fish and Game Commission shall meet on May 31, 1974, at 9:00 a.m. in Room 1138 of the New State Building, 107 South Broadway, Los Angeles, California, to hear and consider any objections to its determinations or proposed orders in relation to mammals for the 1974 hunting season, such determinations resulting from hearing held on May 3, 1974. This notice is published in accordance with the provisions of Section 206 of the Fish and Game Code.

FISH AND GAME COMMISSION
Leslie F. Edgerton
Executive Secretary

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